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(12) UK Patent Application (19) GB (11) 2 298 583 (13) A

(43) Date of A Publication 11.09.1996

(21) Application No 9604787.3

(22) Date of Filing 06.03.1996

(30) Priority Data

(31) 07072348 (32) 06.03.1995 (33) JP

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(51) INT CL⁶

A63B 37/00

(52) UK CL (Edition O)

A6D D1B D1C11 D1C5

C3M MXC

C3V VEM

(56) Documents Cited

GB 2276628 A

GB 2235879 A

GB 2232162 A

US 4840381 A

(58) Field of Search

UK CL (Edition O) A6D D1A D1B D1C11 , C3M MXC ,

C3V VEM

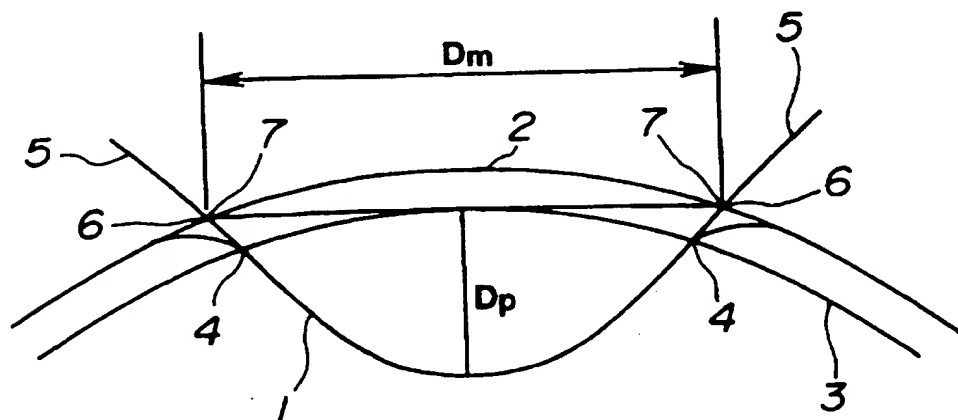
INT CL⁶ A63B

ONLINE:- WPI

(54) Golf ball

(57) A golf ball comprising a solid core enclosed with a cover having a multiplicity of dimples formed therein has a specific gravity of 1.05 ± 0.05 . The cover is formed mainly of ionomer resin to a Shore D hardness of at least 60°. Those golf players with a slow head speed can enjoy the advantages of the ball including an increased flying distance and a pleasant hitting feel. The dimples are such that the volume thereof divided by the volume of a cylinder having the same height as the depth of the dimple and the same diameter is greater than or equal to 0.47.

FIG.1



GB 2 298 583 A

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FIG.1

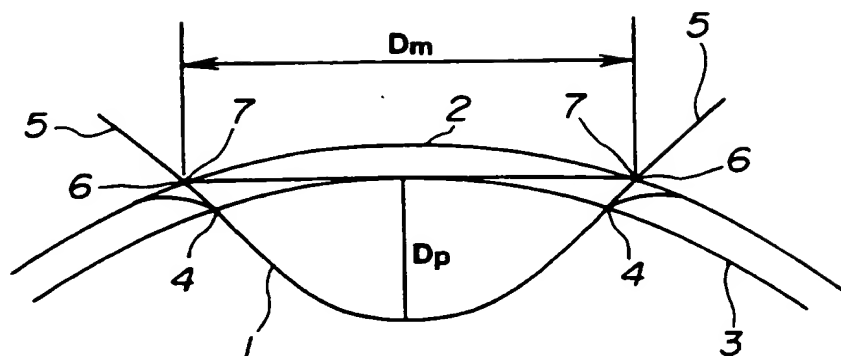
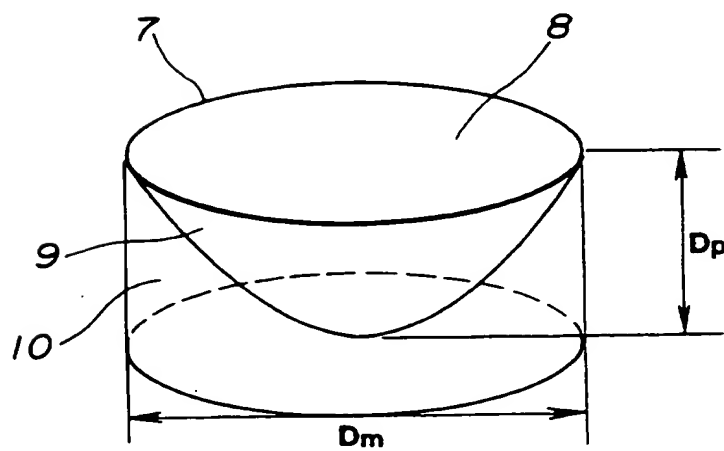
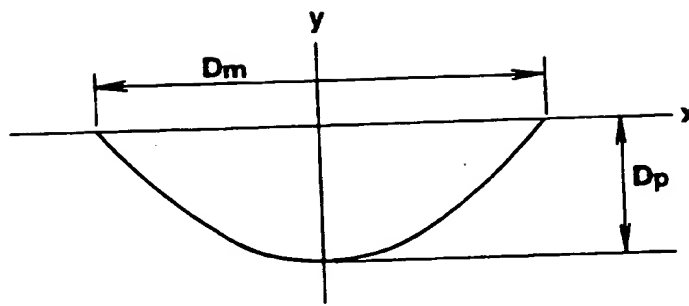


FIG.2



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FIG.3



TITLE OF THE INVENTION

Golf Ball

5

BACKGROUND OF THE INVENTION

10 Field of the Invention

This invention relates to a golf ball suitable for those golf players who swing at a relatively low head speed.

Prior Art

15 For golf balls, various proposals have been made for improving their flying distance and hitting feel.

Most of these advanced golf balls target those golf players who swing at a relatively high head speed, that is, experienced players. Then those golf players capable of
20 high head speed swing can take advantage of the advanced balls, enjoying an increased flying distance and a pleasant feeling. However, those golf players who swing at a low speed and are slow in head speed, including beginner, female and senior players cannot take full advantage of the
25 advanced balls.

Usually, players with a slow head speed select softer ones of the advanced balls. Since the softer balls, however, are not originally designed optimum for slow-head-speed players, the balls follow a low trajectory rather than
30 a high trajectory and offer a less pleasant feel upon hitting.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a
35 novel and improved golf ball which is increased in flying distance and gives a pleasant feel when those golf players

The present invention is directed to a golf ball comprising a solid core and a cover enclosing the core and having a multiplicity of dimples formed therein. The ball has a specific gravity of 1.05 ± 0.05 . The cover is formed mainly from an ionomer resin to a Shore D hardness of at least 60 degrees. Those players who swing at a low head speed of 30 to 40 m/sec., especially about 35 m/sec. take advantage of this ball in games, gaining an increased flying distance and a pleasant feel.

When a golf ball is hit into the air by a club, gravity (g), an aerodynamic lift (L) and an aerodynamic drag (D) act on the flying ball.

$$15 \quad \text{Lift } L = 1/2 \rho V^2 S C_L \quad \dots (1)$$

$$\text{Drag } D = 1/2 \rho v^2 S C_D \quad \dots (2)$$

ρ : air density

v : ball velocity

S: ball cross-sectional area

20 C_L : lift coefficient

C_D : drag coefficient

An inertial force F acts on the ball which is expressed by:

$$\text{inertial force } F = mg + D + L \quad \dots (3)$$

wherein the ball has a mass m . Kinetic equations of the
25 golf ball flying through the air are expressed by the
equations:

$$m\ddot{x} = -D\cos\theta - L\sin\theta \quad \dots (4)$$

$$m\ddot{y} = -mg - D\sin\theta + L\cos\theta \quad \dots (5)$$

wherein θ is an in-flight angle of the ball relative to the
30 ground or horizontal plane.

It is understood that as the mass of the ball is reduced, the inertial force is reduced as seen from equation (3), resulting in a reduced flying distance. This is contradictory to the general demand on golf balls for

increased flying distances. On the other hand, the gravitational action on the ball is reduced as seen from equation (5), resulting in a higher trajectory.

We have found that for those players who swing at a low head speed, a golf ball having a small specific gravity of 1.05 ± 0.05 is adequate in that the player can hit the ball high so as to follow a high trajectory. However, a lightweight ball is accompanied by a reduction of flying distance as mentioned above. We have found that this problem can be overcome by properly selecting the material and hardness of the cover. By forming the cover mainly from an ionomer resin to a hardness of at least 60 degrees on Shore D scale, there is obtained a golf ball which gives a pleasant feel upon hitting and can fly a long distance even when hit at a head speed as low as 35 m/sec.

This finding is derived from our investigation of one-piece and two-piece golf balls in comparison. A comparison is made between a ball of one-piece structure based on butadiene rubber and a ball of two-piece structure wherein a solid core of the same material is covered with a cover of a rigid ionomer resin having a Shore D hardness of at least 60 degrees, provided that both the balls have an identical outer diameter of 42.70 ± 0.05 mm and an identical specific gravity of 1.05 ± 0.05 . The one-piece ball receives a higher spin rate whereas the two-piece ball receives a lower spin rate. The two-piece ball gains a larger launch angle than the one-piece ball. The low spin rate and large launch angle are advantageous especially in the low head speed region. When a golf ball having a specific gravity of 1.05 ± 0.05 and a cover formed mainly from an ionomer resin to a Shore D hardness of at least 60 degrees is shot at a head speed of 45 m/sec., the flying distance is not increased as compared with other golf balls and the hitting feel is unpleasant. When the same golf ball is shot at a head speed of 35 m/sec., the flying distance is significantly increased as compared with other golf balls and the hitting feel is pleasant.

For further improving the flying distance and hitting feel of the golf ball of the invention, it is preferred that the core undergoes a distortion of 2.4 to 4.3 mm under a load of 100 kg and that the cover has a radial thickness of 1.4 to 2.4 mm.

Also the flying distance is further increased when the dimples satisfy the conditions: $V_0 \geq 0.470$ and $V_R \geq 0.8\%$. Provided that each dimple has a circular edge, V_0 is the volume (V_p) of the dimple space below a circular plane circumscribed by the dimple edge, divided by the volume (V_q) of a cylinder whose bottom is the circular plane and whose height is the maximum depth of the dimple from the bottom (that is, $V_0 = V_p/V_q$), and V_R is a percent overall dimple volume given by the formula:

$$V_R = \frac{V_s}{\frac{4}{3}\pi R^3} \times 100\%$$

wherein V_s is a sum of the volumes of the dimple spaces each below a circular plane circumscribed by the dimple edge and the ball has a radius R .

BRIEF DESCRIPTION OF THE DRAWINGS

These and further features of the present invention will be apparent with reference to the following description and drawings, wherein:

FIGS. 1, 2, and 3 are schematic views illustrating how to calculate the dimple space volume and cylinder volume.

DETAILED DESCRIPTION OF THE INVENTION

The golf ball of the present invention is adjusted in specific gravity and cover hardness so that the ball may offer an increased flying distance and a pleasant feel when hit by those players who swing at a relatively low head speed. The invention provides a golf ball comprising a cover on a solid core. A multiplicity of dimples are formed in the cover. According to the feature of the invention,

the ball has a specific gravity of 1.05 ± 0.05 and the cover is composed mainly of an ionomer resin and has a Shore D hardness of at least 60 degrees.

5 The golf ball of the invention is generally a two-piece solid golf ball although it may be a multiple solid golf ball wherein the solid core includes two or more layers. The cover is not limited to a single layer structure and may have a multilayer structure insofar as the above-mentioned requirements are met.

10 The ball has a specific gravity of 1.05 ± 0.05 as mentioned above, preferably from 1.02 to 1.09. A ball having a specific gravity of less than 1.00 is felt light or soft, is likely to receive wind resistance in flight so that its trajectory may be deflected, and is too low in inertial
15 force to cover a long flying distance. On the other hand, a ball having a specific gravity of more than 1.10 is not different from conventional golf balls or usual field-play golf balls, failing to attain the objects of the invention.

The ball should have a weight of not greater than 45.92
20 g as prescribed in the Rules of Golf. For the objects of the invention, the ball preferably has a weight of 40.5 g to less than 45.0 g, especially 41.0 to 44.5 g.

In the golf ball of the invention, the cover is formed mainly of an ionomer resin to a Shore D hardness of at least
25 60 degrees. The cover hardness is not particularly limited insofar as it is 60 degrees or more on the Shore D scale. Preferably the cover has a Shore D hardness of 62 to 68 degrees with a permissible measurement error of ± 3 degrees. If the cover hardness is less than 60 degrees in Shore D,
30 the ball becomes less repulsive and receives a more spin and a larger launch angle upon hitting so that the ball may climb high and stall, failing to cover a long flying distance. Too increased Shore D hardness means that the cover is too hard so that the golf ball may be less durable.

35 Preferably the cover is formed around the core to a radial thickness of 1.4 to 2.4 mm, especially 1.5 to 2.3 mm. A cover of less than 1.4 mm in thickness would be low in cut resistance so that the ball might be less durable. A cover

of more than 2.4 mm in thickness would give a dull feel upon hitting and a ball with such a thick cover would become less repulsive.

Also preferably, the core to be enclosed with the cover
5 undergoes a distortion of 2.4 to 4.3 mm, especially 2.6 to 4.2 mm under an applied load of 100 kg. With a core distortion of less than 2.4 mm, a ball after enclosure with a cover as defined above would give a hard feel upon hitting and be inadequate for golfers with a relatively low head
10 speed. With a core distortion of more than 4.3 mm, the resulting ball would be less repulsive and deteriorated in flying performance. In forming a core, the core should preferably be fully vulcanized to its center to impart restitution to the ball. A core whose interior or center
15 remains unvulcanized is less desirable because the resulting ball becomes less repulsive, short in flying distance, and inferior in hitting feel and durability.

The core may be formed of any desired material by any desired method. Any of well-known materials may be used for
20 the core insofar as a golf ball with desirable properties is obtained.

More particularly, the core of the solid golf ball of the invention is formed by a conventional technique while properly adjusting vulcanizing conditions and formulation.
25 Usually the core is formed of a composition comprising a base rubber, a crosslinking agent, a co-crosslinking agent, and an inert filler. The base rubber may be selected from natural rubber and synthetic rubbers used in conventional solid golf balls. The preferred base rubber is 1,4-
30 polybutadiene having at least 40% of cis-structure. The polybutadiene may be blended with natural rubber, polyisoprene rubber, styrene-butadiene rubber or the like. The crosslinking agent is typically selected from organic peroxides such as dicumyl peroxide and di-t-butyl peroxide,
35 especially dicumyl peroxide. About 0.5 to 3 parts by weight, preferably about 0.8 to 1.5 parts by weight of the crosslinking agent is blended with 100 parts by weight of the base rubber. The co-crosslinking agent is typically

selected from metal salts of unsaturated fatty acids, inter alia, zinc and magnesium salts of unsaturated fatty acids having 3 to 8 carbon atoms (e.g., acrylic acid and methacrylic acid) though not limited thereto. Zinc acrylate is especially preferred. About 10 to 45 parts by weight, preferably about 15 to 40 parts by weight of the co-crosslinking agent is blended with 100 parts by weight of the base rubber. Examples of the inert filler include zinc oxide, barium sulfate, silica, calcium carbonate, and zinc carbonate, with zinc oxide being often used. The amount of the filler blended is preferably 0 to about 40 parts by weight per 100 parts by weight of the base rubber although the amount largely varies with the specific gravity of the core and cover, the weight of the ball, and other factors. In the practice of the invention, the amount of the filler is properly selected in a less loading range so as to provide the desired specific gravity and weight to the ball.

A core-forming composition is prepared by kneading the above-mentioned components in a conventional mixer such as a Banbury mixer and roll mill, and it is compression or injection molded in a core mold. The molding is then cured by heating at a sufficient temperature for the crosslinking agent and co-crosslinking agent to function (for example, a temperature of about 130 to 170°C for a combination of dicumyl peroxide as the crosslinking agent and zinc acrylate as the co-crosslinking agent), obtaining a core.

In the case of a two-layer core, the inner core may be formed of a material similar to the above-mentioned one and the outer core may be formed of a material similar to the above-mentioned one or a resinous material such as an ionomer resin. Typically the outer core is formed over the inner core by compression or injection molding.

Like conventional golf balls, the golf ball of the invention is formed with a multiplicity of dimples in the cover surface. Preferably the ball has about 300 to 550 dimples, more preferably about 360 to 450 dimples. The dimples may be arranged in any desired pattern as in conventional golf balls. There may be two or more types of

dimples which are different in diameter and/or depth. It is preferred that the dimples have a diameter of 2 to 4.5 mm and a depth of 0.10 to 0.23 mm. While the inventive golf ball is adequate for those golfers with a slow head speed, a further improvement in the performance associated with a slow head speed is expectable if specific dimples are formed in the cover surface. Specifically, a constant in-flight angle and a stable trajectory are expectable if the dimples are formed to satisfy the conditions: $V_0 \geq 0.470$, especially $0.53 \geq V_0 \geq 0.475$ and $V_R \geq 0.8\%$. V_0 and V_R are defined as follows. It is assumed that each dimple has a circular edge and the ball has a radius R . Then the dimple space below a circular plane circumscribed by the dimple edge has a volume (V_p), and a cylinder whose bottom is the circular plane and whose height is the maximum depth of the dimple from the bottom has a volume (V_q). V_0 is the dimple space volume (V_p) divided by the cylinder volume (V_q). V_R is a percent overall dimple volume given by the formula: $V_R = V_s / (4\pi R^3 / 3) \times 100\%$ wherein V_s is a sum of the volumes of the dimple spaces each below a circular plane circumscribed by the dimple edge. If V_0 exceeds 0.53, the trajectory would tend to descend. If V_0 is below 0.470, the ball would climb up. If the percent overall dimple volume V_R is less than 0.8%, the in-flight angle would be large so that the ball might climb up and even stall in flight, failing to fly a long distance.

Referring to FIGS. 1 to 3, the shape of dimples is described in further detail. For simplicity sake, it is now assumed that the shape of a dimple projected on a plane is circular. One dimple in a ball surface is shown in the schematic cross-sectional view of FIG. 1. The ball with a radius R has dimples, one of which is depicted at 1, in its spherical surface. In conjunction with the dimple 1, there are drawn a phantom sphere 2 having the ball diameter $2R$ and another phantom sphere 3 having a diameter smaller by 0.16

mm than the ball diameter. The other sphere 3 intersects with the dimple 1 at a point 4. A tangent 5 at intersection 4 intersects with the phantom sphere 2 at a point 6. A series of intersections 6 define a dimple edge 7. The dimple edge 7 is so defined for the reason that otherwise, the exact position of the dimple edge cannot be determined because the actual edge of the dimple 1 is rounded. The dimple edge 7 circumscribes a circular plane 8 having a diameter D_m . Then as shown in FIG. 2, the dimple space 9 located below the circular plane 8 has a volume V_p . A cylinder 10 whose bottom is the circular plane 8 and whose height is the maximum depth D_p of the dimple from the bottom or circular plane 8 has a volume V_q . As shown in FIG. 3, the volume V_p of the dimple space 9 and the volume V_q of the cylinder 10 are calculated according to the following equations. The dimple space volume V_p is divided by the cylinder volume V_q to give a ratio V_0 .

$$V_p = \int_0^{\frac{D_m}{2}} 2\pi xy dx$$

$$V_q = \frac{\pi D_m^2 D_p}{4}$$

$$V_0 = \frac{V_p}{V_q}$$

It is noted that an equivalent diameter is used in the event that the shape of a dimple projected on a plane is not circular. That is, the maximum diameter or length of a dimple projected on a plane is determined, the plane projected shape of the dimple is assumed to be a circle having a diameter equal to this maximum diameter or length, and V_0 is calculated as above based on this assumption.

The golf ball of the invention for game use is prepared in accordance with the Rules of Golf, that is, to a diameter of at least 42.67 mm, preferably 42.67 mm to 42.75 mm and a

weight of not greater than 45.92 g, preferably 40.5 g to less than 45.0 g. The inventive golf ball has a low specific gravity as specified above while such a low specific gravity is preferably achieved by using a solid
5 core having a low specific gravity or light weight.

EXAMPLE

Examples of the present invention are given below by way of illustration and not by way of limitation. All parts
10 are by weight.

Examples 1-6 & Comparative Examples 1-6

Solid cores as shown in Table 1 were prepared by blending the following components.

15	<u>Core components</u>	<u>pbw</u>
	Cis-1,4-polybutadiene rubber (BR01)	100
	Zinc acrylate	18-35
	Zinc oxide	2-25
	Antioxidant	0.2
20	Dicumyl peroxide	0.9

Each compound was molded into a core in a mold and heated at 155°C for about 20 minutes for thoroughly vulcanizing the core. Hardness was adjusted by changing the amounts of zinc acrylate and zinc oxide. Also barium sulfate was used as a
25 gravity adjuster so that the resultant golf balls had the weight shown in Table 1.

Cover materials were prepared by blending ionomer resins as shown below. The cover materials were injection molded over the solid cores to produce two-piece solid golf
30 balls as shown in Table 1.

Cover materials

(1) Shore D hardness 65°

a 50/50 (weight ratio) blend of Himilan 1608/Himilan 1706

35 (2) Shore D hardness 62° and 63°

a 50/25/25 (weight ratio) blend of Himilan 1605/Himilan 1706/Himilan 1557

(3) Shore D hardness 58°

a 50/50 (weight ratio) blend of Himilan 1605/Surlyn
8120

5 The two-piece golf balls had an octahedral arrangement
of dimples of types A and B as shown below. The dimples
were formed so that the percent overall dimple volume V_R was
0.86%.

	<u>Dimple</u>	<u>Type A</u>	<u>Type B</u>
	Diameter (Dm), mm	3.75	3.50
10	Depth (Dp), mm	0.200	0.200
	V_0	0.480	0.480
	Number	144	216

15 Using a swing robot manufactured by True Temper Co.,
the golf balls were hit by a driver at a head speed (HS) of
35 m/sec. and 45 m/sec. for determining spin, launch angle,
carry, total, and in-flight angle. The driver had a loft
angle of 10.5° at HS 45 and 12.5° at HS 35.

20 Using a panel of three male professional golfers (head
speed 45 m/sec.) and three female senior players (head speed
35 m/sec.), the balls were evaluated for hitting feel
according to the following rating.

25 ©: pleasant
 O: soft
 Δ: fairly hard
 X: light and too soft

Table 1

	Example						Comparative Example					
	1	2	3	4	5	6	1	2	3	4	5	6
Core												
Outer diameter (mm)	38.70	38.67	38.67	39.71	38.10	38.10	-	38.70	38.70	-	38.10	38.70
Weight (g)	31.50	32.76	34.21	35.31	31.17	31.17	-	35.30	35.30	-	28.62	31.50
Hardness ¹⁾	2.6	3.0	3.5	3.3	3.3	4.2	-	3.5	2.3	-	3.3	2.6
Cover												
Thickness (mm)	2.00	2.00	2.00	1.50	2.30	2.30	-	2.00	2.00	-	2.30	2.00
Hardness ²⁾	63	65	63	62	63	63	-	63	63	-	63	58
Ball												
Outer diameter (mm)	42.70	42.67	42.67	42.71	42.70	42.70	42.70	42.70	42.70	42.67	42.70	42.70
Weight (g)	41.50	42.75	44.20	43.00	42.50	42.50	43.00	45.30	45.30	39.87	39.95	41.50
Specific gravity	1.02	1.05	1.09	1.05	1.04	1.04	1.05	1.11	1.11	0.98	0.98	1.02
HS45/#W1												
Spin (rpm)	2800	2550	2410	2510	2430	2310	3265	2630	2950	3210	2390	2900
Launch angle (°)	9.6	9.9	10.1	9.9	10.1	10.2	9.1	9.8	9.6	9.21	10.2	9.4
Carry (m)	212.5	213.0	213.4	213.2	213.0	212.9	210.7	213.5	214.0	20.85	209.0	212.5
Total (m)	222.8	223.0	224.5	224.0	223.2	229.7	220.5	226.4	225.5	218.6	219.3	225.0
Angle (°)	12.8	12.7	12.5	12.6	12.7	12.7	12.7	12.3	12.4	12.9	12.8	12.9
Feel	Δ or X	X	X	X	X	X	Δ or X	⊙	O	Δ or X	X	O
HS35/#W1												
Spin (rpm)	3360	3060	2892	3012	2916	2713	3918	3156	3540	3852	2868	3480
Launch angle (°)	10.7	11.0	11.2	11.0	11.2	11.4	10.2	10.9	10.7	10.3	11.3	10.5
Carry (m)	146.5	147.0	147.5	147.0	146.5	147.1	143.0	143.5	144.0	142.0	143.4	144.1
Total (m)	157.0	157.5	158.2	158.0	157.5	158.8	150.2	154.0	153.5	149.5	153.8	154.0
Angle (°)	13.4	13.3	13.1	13.2	13.3	13.4	13.3	12.9	13.0	13.5	13.4	13.5
Feel	⊙	⊙	⊙	⊙	⊙	⊙	⊙	O	Δ	⊙	⊙	Δ

1) distortion (mm) under an applied load of 100 kg

2) Shore D hardness

There has been described a golf ball having a specific gravity and a cover hardness in the above-defined range. Those golf players with a relatively slow head speed can enjoy the advantages of the ball including an increased flying distance and a pleasant hitting feel.

5 Japanese Patent Application No. 72348/1995 is incorporated herein by reference.

Although some preferred embodiments have been described, many modifications and variations may be made thereto in the light of the above teachings. It is
10 therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

CLAIMS:

1. A golf ball comprising a solid core and a cover enclosing the core and having a multiplicity of dimples
5 formed therein, said ball having a specific gravity of 1.05 ± 0.05 and said cover being composed mainly of an ionomer resin and having a Shore D hardness of at least 60 degrees.
2. The golf ball of claim 1 wherein said cover has a
10 radial thickness of 1.4 to 2.4 mm.
3. The golf ball of claim 1 wherein said core undergoes a distortion of 2.4 to 4.3 mm under a load of 100 kg.
- 15 4. The golf ball of claim 1 wherein provided that each dimple has a circular edge, the dimples satisfy the following conditions:
$$V_0 \geq 0.470 \text{ and } V_R \geq 0.8\%$$

wherein V_0 is the volume of the dimple space below a
20 circular plane circumscribed by the dimple edge, divided by the volume of a cylinder whose bottom is said circular plane and whose height is the maximum depth of the dimple from the bottom, and
$$V_R$$
 is a percent overall dimple volume given by the
25 formula: $V_R = V_s / (4\pi R/3) \times 100\%$ wherein V_s is a sum of the volumes of the dimple spaces each below a circular plane circumscribed by the dimple edge and R is a radius of the ball.
5. A golf ball substantially as herein described with reference to the accompanying illustrative drawings.



Application No: GB 9604787.3
Claims searched: 1-5

Examiner: David Whitfield
Date of search: 29 April 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): C3V VEM C3M MXC A6D D1A D1B D1C11

Int Cl (Ed.6): A63B

Other: ONLINE:- WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X:Y	GB 2276628A (BRIDGESTONE) (WHOLE DOCUMENT)	1-3:4
Y	GB 2235879A (SUMITOMO) (see table 3 line 1 at least)	4
X:Y	GB 2232162A (") (see table 1 ex. 4)	1,2:4
Y	US 4840381 (BRIDGESTONE) (see col 2,1 49- col 3, 1 1 & col 4 ll 37-40)	

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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A Documents indicating technological background and/or state of the art.
P Documents published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

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FIG.1

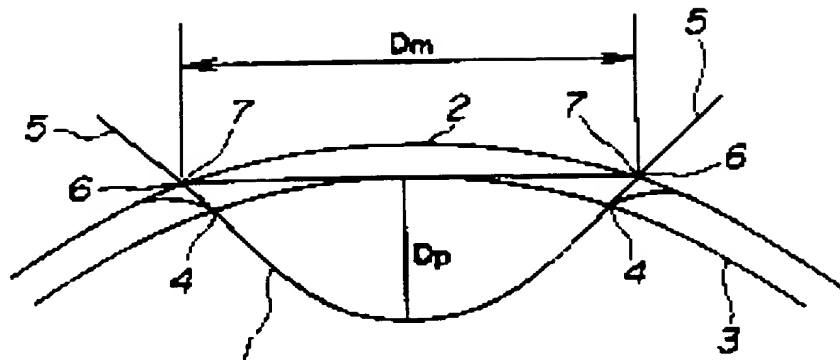
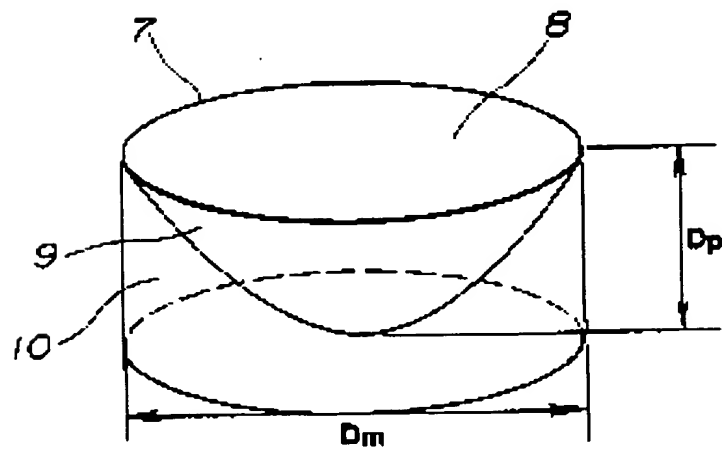


FIG.2



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FIG.3

